Mr Rothberg

RK PLAN

WATERSHED PROTECTION AND FLOOD PREVENTION

UPPER TRADEWATER RIVER WATERSHED

Christian and Hopkins Counties, Kentucky

OUR SOIL ★ OUR STRENGTH

WATERSHED WORK PLAN

UPPER TRADEWATER RIVER WATERSHED

Christian and Hopkins Counties, Kentucky

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666) as amended

Prepared by

Christian County Soil Conservation District
Upper Tradewater River Watershed Conservancy District

With Assistance by
U.S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, Forest Service
Kentucky Division of Forestry

April 1964

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SUMMARY OF PLAN

The work plan for the Upper Tradewater River Watershed was prepared by the Christian County Soil Conservation District and the Upper Tradewater River Watershed Conservancy District, as the Sponsoring Local Organizations. Technical assistance was provided by the Soil Conservation Service and the Forest Service of the U.S. Department of Agriculture and the Kentucky Division of Forestry.

The watershed covers an area of 60,000 acres in two southwestern Kentucky counties. There are 59,550 acres in Christian County and 450 acres in Hopkins County. With the exception of 5,800 acres belonging to the Commonwealth of Kentucky all of the land is privately owned. There are 494 farms and portions of farms in the watershed. Of the 113 Soil Conservation District Cooperators, 34 have basic conservation plans.

The major problem in the watershed is damage by floodwater and sediment to crops and pasture, farm improvements and to transportation facilities. Considerable crop damages by floods occur on an average of once each year during the cropping season. Approximately 80 percent of the floodplain is inundated by floodwaters an average of once every five years during the cropping season and 60 percent is flooded an average of once every three years. The frequent and rather widespread flooding causes an estimated average damage of $13,301 annually. About 100 families involving 94 farms are adversely affected by these damages and it is estimated that the average damage per farm is about $130 annually.

The proposed project was formulated to include all feasible measures that would provide the optimum solution to these problems. It includes a combination of land treatment measures and a system of structural measures, consisting of eight (8) floodwater retarding structures and about fourteen (14) miles of stream channel improvement. The accelerated land treatment program will consist of the essential treatment of 6,010 acres of cropland, 17,970 acres of grassland and 2,100 acres of woodland. The plan proposes the installation of the project in about 5 years at an estimated total cost of $2,052,460. The P.L. 566 share of this cost is $811,310

and the other than P.L. 566 cost is $1,241,150.

The proposed project will provide the evaluated floodplain (2,963 acres) with a 5-year minimum level of protection. In addition, an estimated 950 acres will receive benefits not measured for evaluation of the project. Agricultural damages on about 94 farms will be reduced by about 80 percent and road and bridge damages by 91 percent. The project will allow for a more intensive use of 1,511 acres of floodplain land, thus making it possible to shift a considerable acreage of row crops from the erodible class II and III upland to the nearly level bottomland. It is estimated that gross erosion in the watershed will be reduced by about 15 percent.

The present land use includes 14,630 acres of cropland, 18,480 acres of grassland, 16,120 acres of woodland, and 10,770 acres of other, mainly non-productive, private and public uses. The anticipated future land use includes 11,700 acres of cropland, 26,300 acres of grassland, 17,500 acres of woodland, and 4,500 acres of other uses. The estimated decrease in cropland (2930 acres) and increases in grassland (7820 acres) and woodland (1380 acres) uses can be attributed to the project to a considerable extent.

The structural measures will be installed at an estimated average annual cost of $28,988 and will provide an estimated average annual primary benefit of $41,215. The benefit-cost ratio for the structural measures is 1.4 to 1.0.

The Upper Tradewater River Watershed Conservancy District will secure, without cost to the Federal Government, all needed land, easements, and rights-of-way and will operate and maintain the structural works of improvement.

DESCRIPTION OF THE WATERSHED

Physical Data

Upper Tradewater River Watershed is bordered on the east by U.S. Highway 41 and the Louisville & Nashville Railroad serving Crofton, on the north by the Christian, Hopkins County line, and on the west by and including 5,800 acres of the Pennyrile State Forest. Three blacktop roads other than U.S. 41 traverse the watershed. They are Kentucky 109, Kentucky 800, and Kentucky 1348. Tradewater River heads about five miles north of Hopkinsville, Kentucky within the drainage area of Buntin Lake. The river flows in a northwesterly direction. The major tributaries are, in downstream order, Dripping Spring Branch, Brushy Fork, Whitehorn Creek, Sandlick Creek, Castleberry Creek, Morgan Creek, Sugar Creek and McKnight Creek. The designated watershed terminates at the mouth of Buffalo Creek about 1.5 miles south of Dawson Springs, Kentucky.

The topography of the watershed varies from gently rolling farmland to steep tree covered hills. The bottomlands are fairly wide and the main stream is characterized by meanders except in the upper and extreme lower regions of the watershed. The northern half of the watershed lies within the Western Coal Fields physiographic region. The topography is a little rougher here than the area to the south. The southern half of the watershed is within the Mississippian plateau physiographic area.

The soils of the watershed are of sandstone, limestone and shale origin and influenced by loess material. The principal upland soils are Zanesville, Tilset and Wellston. Zanesville and Tilsit are moderately well-drained soils with fragipans, while Wellston soils are well-drained without a fragipan. These soils are used for rotation cropland.

The steeper slopes are Montevallo (formerly known as Muskingum), Gilpin and Wellston. The Montevallo soils are very rocky, shallow and excessively drained, while Gilpin and Wellston are well-drained and moderately deep. These steeper slopes are mostly in woodland and pasture.

The bottom soils are Pope, Philo, Stendal and Atkins. These soils are alluvial sediments from the sandstone and shale uplands. Pope soils are well-drained; Philo, moderately well-drained; Stendal, somewhat poorly drained; and Atkins, poorly-drained. Philo and Stendal will respond well to tile drainage, while Atkins will be greatly improved.

There are also some "high bottom" or terrace soils. These are Holston, which is well-drained, and Mongahela, which is moderately well-drained.

The cover conditions of the northern half of the watershed are fair to poor except the Pennyrile Forest area which is in very good forest cover. The general cover conditions of the southern half of the watershed range from fair to good. Of course there are farms scattered throughout the watershed which have good cover as well as some with poor cover, depending upon management and land treatment.

Since the number of individuals in a fish or wildlife population is rarely precisely known, the size of a population is usually described as rare, common, or abundant. This method of rating was used in this survey except in a few instances where a combination of the accepted terms was thought to be more descriptive of the true status of the population.

Using this system, rabbits and groundhogs were found to be abundant. Bob-white quail were rated between common and abundant. Gray squirrels, mourning doves, whitetailed deer, raccoons, opossums, mink, muskrats, gray foxes, non-game birds, and game and pan fishes in farm ponds were considered common. Fox squirrels, skunks, and both rough and pan fishes in streams were rated between rare and common. Only ruffed grouse and red foxes were considered rare. Ducks are found on the area only when the bottoms are flooded and the Mississippi Flyway duck population is common or abundant.

Springs, drilled wells and cisterns furnish water for domestic purposes in the watershed. Livestock drink from ponds, springs and streams and some are watered from wells.

The average annual precipitation is about 49 inches, with the greatest amounts occurring in December, January, March and June, and the smallest amounts falling in September and October. The length of growing season is about 192 days with the first and last killing frosts occurring about October 21 and April 12, respectively.

Economic Data

Basically, the economy of the watershed is agricultural, depending almost entirely upon the production and sale of farm products. Some coal is being stripmined on a very limited scale in the east central portion of the watershed. Farming operations are generally well balanced, with both cultivated crops and livestock production over about 30 percent of the watershed area. Extensive woodlands and some grassland farming operations are evidenced in the upland areas where steep and erodible slopes prevent sustained cultivation for clean tilled crops. These steep areas comprise nearly one-half of the total watershed. The remaining areas, the valley portions, are generally farmed most intensively for row crop production.

The predominantly rural population of the watershed area, including about 300 of the people in Crofton, Kentucky is estimated to be 2,800. Approximately 520 resident families are engaged full time in the operations of some 494 farming units located wholly or partially within the watershed. These units range in size from small tracts of under 20 acres to large multi-family units of several hundred acres. The median size farm is about 125 acres having an estimated average present market value of land, buildings and other fixed capital improvements of slightly above $9,000. Owner operated farms comprise about 75 percent of the total units, about 15 percent are tenant operated, and about 10 percent are marginal or non-operating farm units.

Of the total watershed area, nearly ten percent is included in portions of the Pennyrile Forest State Park, and the Outwood Hospital, recently converted from a hospital for war veterans to its current use as a state institution for retarded children. These state-owned and operated developments, located on the west and north boundaries of the watershed, are mainly in heavy woodland cover.

An estimated current land use breakdown includes 14,630 acres of cropland, 18,480 acres of permanent grassland, 16,120 acres of woodland, 9,000 acres idle and 1,770 acres in various other private and public uses. There are some coal mining company holdings located in the northwest portion of the watershed that are included in the above non-farm acreages. Approximate cropland rotations include 52 percent corn, 4 percent soybeans mainly for grain harvest, 12 percent small grains, 21 percent hay crops, 5 percent rotation pasture, and 6 percent various other crops including tobacco, gardens, orchards, and other minor acreage crops.

Total farm income is made up of approximately 60 percent from cash crop sales and 40 percent from marketings of livestock, dairy and poultry products. In terms of volume of gross income, corn, tobacco, soybeans and small grains are the major cash crops. Beef cattle, hogs, and sheep are the main livestock enterprises. Dairying, poultry production and timber marketings each vary widely in relative importance among individual farming enterprises. The production, transportation and marketing of agricultural products, and related services to farmers and farm families, are the principal economic activities involving the people, the land, and the wealth of the watershed area.

Approximately 27 percent of the watershed is in forest cover. Hardwood stands occupy 93 percent of the area. The principal hardwood species are Red oak, White oak, Black oak, Hickory and Yellow poplar. The remaining 7 percent is in softwood stands. Of this area 800 acres are in plantations of various ages and the remainder in natural stands of Virginia pine. Approximately 38 percent of the forest area supports timber stands of 1,500 board feet per acre or more, 50 percent is in pole size stands and 12 percent in seedling and sapling stands. Adequate forest fire protection is provided by the Kentucky Division of Forestry in cooperation with the U.S. Forest Service through the Cooperative Fire Control Program.

Nearby farm supply centers and market outlets for agricultural products are accessible to all farms of the watershed. These include Hopkinsville, Dawson Springs, Madisonville, Princeton and Bowling Green, Kentucky. The principal means of transporting farm

products and supplies is by motor truck, farmer owned or contracted. The Louisville and Nashville Railroad traverses the west boundary of the watershed serving Crofton, Kentucky, the only incorporated town in the watershed.

WATERSHED PROBLEMS

Floodwater Damages

The frequent floodwater damages to growing crops, resulting in sizeable losses of farming income, is the major watershed problem. An average of about two floods, often three or four, occur during a calendar year, with the greatest concentration in the winter and early spring months. Considerable crop damages by floods occur an average of once per year during the cropping season, May through mid November. Approximately 80 out of each 100 acres of cropland in the floodplain of Upper Tradewater River Watershed are inundated by floodwaters an average of once every five years during the cropping season, and nearly 60 percent is flooded an average of once every three years. Depending on the time of occurrence in relation to the overall stage of growth and maturity of crops, the event of a flood during the cropping season, or its absence, largely determines the financial failure or success of floodplain farming operations for the year.

Of the total watershed area, some 7 percent is subjected to repeated flooding by the Upper Tradewater River and its major tributaries. Slightly more than 100 families are presently engaged in management and operation of 94 farms with sizeable acreages of bottomlands that are adversely affected by damaging floodwaters and sediment. Because these areas are the most fertile and productive land of almost every farming unit, practically all cultivation each year for row crops, is concentrated in the floodplain. The management decisions of farmers generally take into account the high risk of flood damage to their crops when determining their optimum production inputs, such as type of crops, rotations, fertilizers and chemicals. As a result of these high risk conditions, the levels of management and intensity of floodplain land use are below the inherent flood-free capabilities of the soils.

Cropland seedings are normally established rather late seasonally because of the wet spring period and length of time required for the bottomland soils to dry out. Subsequent floods during the cropping season usually cause damages to crops that are not recoverable. Complete crop failures are not exceptional on bottomland farms. One such year was in 1960 when major flood damages occurred in late June. A relatively high rate of turnover in bottomland farm tenants and owners is evidenced in this watershed. However,

the land market value of bottomlands as compared to uplands throughout much of the watershed is currently about three-to-one on a per acre basis, reflecting the real comparative advantage value of floodplain crop production potential.

Based on the evaluation of flood losses over 2,963 acres of floodplain area, the damages to crops and pasture are estimated to average $9,582 annually. Other floodwater and sediment damages include an estimated $1,501 annually to fences and other fixed farm improvements, $1,006 annually to public roads, bridges and culverts, and $1,212 annually indirect-type damages which include disruptions of traffic, delay losses of wages and income to businesses, farmers, and various public and private services, and similar inconveniences to the traveling public.

In many cases, frequent flood losses result in low income, submarginal operations on farms that would otherwise be suitable for economically adequate family farming units. In other cases, a few farm units have been abandoned for some years because of repeated crop failures due to floods. In view of pressing local needs for more family housing and employment opportunities, the watershed community can ill afford continuation of these losses in the valley areas.

Erosion and Sedimentation Damages

On the basis of field observations, and interviews with local technicians and farmers, it was determined that erosion and sediment damages were relatively minor so were not separately evaluated. However, some sediment damages do occur which are inseparable from floodwater damage.

PROJECTS OF OTHER AGENCIES

There are no existing or planned works of improvement of other agencies which will materially affect or be affected by the works of improvement proposed in the plan.

BASIS FOR PROJECT FORMULATION

The watershed project was formulated to include all feasible systems of measures that will provide the most favorable solution to the soil and water management problems.

Floodwater and sediment damages to agricultural lands and to transportation facilities are the major problems in the watershed. The frequent flooding prevents the most efficient use of the floodplain and often leads to the improper use of portions of the

upland. The overall economy of the watershed is adversely affected by the severe flooding problem. Consideration was given to the applicability of other agricultural and non-agricultural structural works of improvement, such as for drainage and water storage. It was agreed that these purposes do not constitute major needs in this watershed.

An agreement was reached with the Sponsoring Local Organizations on the desired level of protection, by reaches, and on the principal types of measures that would be required to achieve their objectives. A land treatment program, based on soils capability classifications, was considered the first increment in project formulation. Studies revealed that an acceleration of the going land treatment program would be effective in producing floodwater reduction benefits, in addition to the enhancement of the economy of the entire watershed. There are 113 Soil Conservation District Cooperators out of a total of 494 operating units. Thirty four (34) of these have basic conservation plans. The accomplishments to date in the application of these measures are shown on Table 1A and the amounts to be applied during the 5-year project period are shown on Table 1.

To supplement the land treatment program a system of waterflow control measures was considered. These measures consist of eight (8) floodwater retarding structures and about fourteen (14) miles of channel improvement. The channel improvement was considered as supplementary to the floodwater retarding structures. The most favorable system was arrived at by testing alternate combinations. The floodwater retarding structures are designed in accordance with the criteria contained in SCS Engineering Memorandum No. 27 and the improved channels are designed to contain within bank the peak discharge from a five-year frequency growing season flood. All of the structural measures are planned for flood prevention only.

The level of protection provided by the proposed project is sufficiently high to encourage a more intensive use of the floodplain.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An accelerated land treatment program was given primary consideration in the formulation of a project for the protection and development of the watershed. Proper land use and treatment is essential to protect and improve the soil and water resources of individual farms and at the same time provide the highest

feasible degree of runoff retardation, erosion control and water management. They are also required in reducing sedimentation hazards that would adversely affect the installation, operation and maintenance of the structural measures.

To achieve the above objective essential treatment will be applied to about 6,010 acres of cropland, 17,970 acres of grassland and 2,100 acres of woodland.

The cropland treatment will involve using a cropping system along with the needed cultural, structural and management measures to keep soil losses within allowable limits and to improve or at least maintain the physical condition of the soil. In capability class I and sub-class IIw a one-year cropping system will be supplemented with cover crops, minor drainage practices, and crop residue use. For capability sub-classes IIIw and IVw a sod based cropping system along with major drainage practices will be needed. Various alternatives of cropland treatment will also be possible on the upland areas. For example, for capability class IIe, a four year cropping system with contour cultivation may be adequate to achieve the treatment objective; however, by using terraces, grassed waterways, etc. a much shorter cropping system may be used and still keep soil losses within permissible limits. The treatment used will be based on the decision of the farm operator after careful consideration has been given to the various alternatives. The grassland treatment will include such measures as pasture plantings and renovation and the construction of farm ponds and open drainage ditches. Strip mine areas will be treated by plugging the pit opening, during or immediately following mining operation, to trap the sediment within the interior of the strip mine. The perimeter of the spoil banks will be planted to trees or a combination of grasses and trees.

The forest land treatment program consists of 500 acres of tree planting, 1,100 acres of hydrologic stand improvement and harvest cutting, and 500 acres of woodland grazing control. These measures insure proper forest land treatment and maximum watershed protection and help reduce runoff and erosion by furnishing protection to the soil and increasing the infiltration rates and storage capacity of the forest soil profile.

The general trend in land use in the past, in this general area, has been toward less cropland and more grassland and woodland. It is reasonable to assume that this trend will continue.

The additional technical assistance needed to achieve the goals for the land treatment program includes about 445 man-days of soil survey time.

Structural Measures

Floodwater Retarding Structures:

Eight floodwater retarding structures are planned with preliminary design, calculated quantities and estimated cost prepared for each. They are located as follows: No. 1 is located on the upper main stem of Tradewater River as shown on the Pleasant Green Hill, Kentucky, 7½ minute U.S.G.S. topographic quad sheet at coordinates 1,482,600 - 247,000; the other seven are located on the Dawson Springs SE, Kentucky 7½ minute U.S.G.S. topographic quad sheet as follows: No. 3 is located on Brushy Fork at coordinates 1,472,000 - 258,200; No. 7 is on Dripping Spring Branch at coordinates 1,485,400 - 201,600; No. 10 is on Sandlick Creek at coordinates 1,461,600 - 260,500; No. 11 is on Tugler Creek at coordinates 1,458,400 - 262,600; No. 8 is on White Horn Creek at coordinates 1,474,800 - 268,000; No. 5 is on Castleberry Creek at coordinates 1,470,400 - 277,000; and No. 9 is on a tributary to Sandlick Creek located in the Pennyrile Forest State Park at coordinates 1,474,700 - 267,800.

Each of these structures consists of an earthfill dam, a principal spillway of reinforced concrete open top drop inlet, ported at the 50-year sediment level and a reinforced concrete pipe, 24 inches in diameter or larger, and an emergency spillway to discharge flows that are in excess of the capacity of the principal spillway and designed temporary storage. The emergency spillways were designed with rockcut costs balanced with earthfill cost to give the most economical design. This resulted in minimum bottom widths of the emergency spillways. All emergency spillway flow will be contained in rock.

The eight structures control about 57 percent of the area contributing directly to flood discharge. All were designed as class "a" structures with runoff control ranging from 2.19 inches for structure No. 9 to 4.71 inches for structure No. 5. The total floodwater detention capacity for the eight structures is 7,439 acre feet and the total sediment capacity is 2,189 acre feet. Sediment storage requirements were determined in accordance with SCS Engineering Memorandum No. 16, and are adequate for final design. Geologic and soil conditions appear to be satisfactory at all sites.

Channel Improvement

In conjunction with the eight floodwater retarding structures, channel improvement has been planned on 73,280 feet of the main stream and tributaries to provide a 5-year level of protection

during cropping season. Improvement starts at cross section B-3, coordinates 1,478,400 - 263,100 on the 7½ minute, Dawson Springs SE, Kentucky, topographic quad sheet and ends at cross section C-87 at coordinates 1,452,600 - 287,600 on the Dawson Springs SW, Kentucky 7½ minute topographic quad sheet.

No improvement is required in Reaches I, II, III and V. 4,400 feet of clearing and snagging and 3,100 feet of channel enlargement is planned in Reach IV. Improvement planned in the other reaches is as follows: Reach VI, 1,500 feet of clearing and snagging; Reach VII, 6,200 feet of clearing and snagging; Reach VIII, 1,800 feet of clearing and snagging and 4,000 feet of channel enlargement; Reach IX, 5,400 feet of clearing and snagging; Reach X, 2,400 feet of clearing and snagging and 8,550 feet of channel enlargement; and in Reaches XI and XII, 4,100 feet of clearing and snagging and 21,200 feet of channel enlargement and/or relocation. Also included is the improvement of major tributary confluences.

EXPLANATION OF INSTALLATION COSTS

The total estimated cost for installing the land treatment measures is $1,271,100. The other than P.L. 566 share of this cost is $1,181,950 and includes $26,550 for technical assistance. The $26,550 will be provided under the authority of other going programs. The P.L. 566 share is $89,150 and will supplement funds available under other going programs for the planning and application of the land treatment measures.

The estimated costs for installing the land treatment measures are based on 1963 cost data.

The estimated total installation cost for structural measures, as shown in Table 2, is $781,360, consisting of $722,160 P.L. 566 cost and $59,200 other than P.L. 566 cost.

The P.L. 566 share of the installation cost for eight (8) floodwater retarding structures is $628,130, which includes $459,740 for construction costs, $99,480 for engineering and geologic services, and $68,910 for other services and overhead costs. The other than P.L. 566 share for these structures is $48,500, including $4,800 for the administration of contracts and $43,700 for land, easements and rights-of-way.

The P.L. 566 share for the installation of channel improvements for flood prevention is $94,030, which includes $66,690 for construction costs, $16,670 for engineering and geologic services, and $10,670 for other services and overhead costs. The other than P.L. 566 cost for these channel improvements is $10,700, including

$660 for the administration of contracts, and $10,040 for land, easements and rights-of-way.

Construction costs for all structural works of improvement consist of the Engineer's estimate plus a twelve (12) percent allowance for contingencies. Cost estimates are based on current cost data of most recent contracts for similar improvements in nearby projects. Adjustments of unit costs were made as deemed necessary, on the basis of current cost trends and according to review with and approval by the State Conservation Engineer and the Construction Engineer. Estimates of costs for engineering and geologic services were determined from actual costs for recently installed project measures. The State Conservation Engineer's office records include accumulative contract costs on these items, and the most recent data were applied on the basis of percentages of the total construction cost.

Estimated Schedule of Obligations

	P.L. 566	Other	Total
First Year	$ 63,560	$250,000	$313,560
Second Year	177,000	255,000	432,000
Third Year	192,500	260,000	452,500
Fourth Year	191,500	250,000	441,500
Fifth Year	186,750	226,150	412,900

EFFECTS OF WORKS OF IMPROVEMENT

The combined effects of project land treatment measures and structural measures for flood prevention will greatly reduce the major problems of the 60,000 acre watershed of the Upper Tradewater River. This project meets the predetermined watershed objectives considered necessary for proper management of the soil and water resources, and the remedy of those problems that are major in scope and beyond the practical capabilities of individual farmer action.

Application of the project land treatment measures will serve to eliminate many of the existing soil erosion and water runoff problems, field by field, on individual farms. These various mechanical and vegetative measures are designed to prevent the excessive losses of topsoil and soil moisture so essential to productive farming in this area. They will make it possible and practical for farmers to more fully carry out land use and crop

rotation practices within the capabilities of the soils and topography. They will provide the overall basis for sound farm management, as well as effecting reductions of downstream damages through greater control of floodwaters and sediment at their points of origin.

The effects of land treatment measures will reduce soil loss by sheet erosion and gully type erosion (strip mine spoil banks) by about 15 percent. This reduction may be effective during the first 15 years of the watershed program. Of course, it is expected that additional land treatment measures will continue to be installed thereafter.

Anticipated overall land use in the Upper Tradewater River Watershed, consistent with soils capability classification, is estimated to include: cropland, 11,700 acres; pasture and meadow, 26,300 acres; woodland, 17,500 acres, wildlife area, 2,400 acres; and, other private and public uses, 2,100 acres. These estimates are indicative of established land use trends in this area, toward reductions of cropland and increases of grassland and woodland uses.

Floodwater and sediment damages are measured in terms of flooding frequencies associated with area affected. Under present conditions, flood damages occur an average of once per year during the cropping season, and an average of about twice during a calendar year period. Approximately 2,200 acres are flooded during the cropping season by floods that occur an average of once in five years. About 1,700 acres are inundated by the three-year frequency floods. Based on measured project effects, a five-year level of protection during the cropping season will be provided in all evaluation reaches, except the lower Reach XII where less than 150 acres will receive only inches of flooding an average of about once every five years. In terms of annual floods, estimated reductions by the project are as follows: 100-year frequency, reduced from 2,963 acres flooded to 2,404 acres flooded; 10-year frequency, from 2,756 acres to 2,021 acres; 5-year frequency, 2,665 acres to 1,900 acres; 3-year frequency, 2,569 acres to 1,568 acres; and 1.5 year frequency, 2,221 acres reduced to 665 acres. Even greater flood damage reductions are effected by the project works of improvement with the decrease of relative depths of floodwater on the above remaining areas flooded.

Approximately 80 percent of the total evaluated floodplain area is being flooded too frequently for farmers to risk intensive land management practices. With the project installed, an adequate level of protection will be afforded some 90 farms for a more intensive cropping program over about 2,000 acres. This reduction of flooding hazard will permit farmers to shift acreages of corn,

tobacco, small grains and hay crops from adjacent upland slopes to the more fertile floodplain areas. The net effect of these changes in land use, as indicated by the farmers involved, will be the more efficient and profitable farming of bottomland farms throughout the watershed.

Considerable savings in flood damage repair and replacement costs on public roads, bridges and culverts, fences and other fixed farm improvements will be effected by the project. These improvements located in the flooding areas of Upper Tradewater River and its major tributaries, are damaged by floodwaters, sediment and debris an estimated average of $2,758 annually. These damages will be reduced some 85 percent by the project. The disruptions of traffic by floods will be reduced to very infrequent occurrences throughout the benefited area of the watershed.

PROJECT BENEFITS

The present total floodwater and sediment damages over 2,963 acres of evaluation floodplain is estimated to average $13,301 annually. The effects of project land treatment measures will reduce these damages an estimated average of $669 annually, with much greater on-site benefits through conservation of the soil and water resources of individual farms where they are installed. After the installation of structural measures, floodwater retarding structures and stream channel improvements, these damages will be further reduced an estimated average of $10,130 annually. These damage reduction benefits by structural measures are distributed as follows: crops and pasture, $7,208; fences and other farm improvements, $1,140; public roads, bridges and culverts, $858; and, indirect type benefits, $924. This represents a total damage reduction benefit of 81 percent. The remaining floodwater and sediment damages, estimated to be $2,502 annually, are not expected to limit efficiencies in the agricultural use and management of floodplain land.

Average annual flood damages to fences and other farm improvements are estimated to be $1,501. Reduction of these damages by the project is an estimated 81 percent.

Public roads, bridges and culverts are damaged by floods an estimated average of $1,006 annually. After installation of the project works of improvement, these damages will be reduced an estimated 91 percent.

Estimated indirect-type flood damages average $1,212 annually. Project land treatment measures and structural measures will reduce these damages an estimated 81 percent.

Field interview studies indicate that farmers will gradually change the present use and/or intensity of use of some 1,511 acres out of a possible 2,010 acres of floodplain land upon which sufficient reduction of existing frequencies of flooding will be effected by the project works of improvement. An estimated total of 260 acres of low income brushy land and wooded areas will have sufficient reductions in flooding frequency (five year level of protection) for conversions to cropland uses. Of this total acreage, farmers indicate their intentions to convert some 196 acres to cropland over a period of 10 years after the project is installed. The estimated average annual net benefit of these land use changes is $7,079. Approximately 1,750 acres of existing cropland and pasture will have sufficient flooding reductions effected by the project measures to allow farmers to efficiently and profitably intensify the use and management. Of this total, some 1,315 acres are expected to be farmed more intensively within a period of 15 years after the project is installed. About 75 percent of these more intensive farming programs will likely be initiated during and within 5 years after the project installation period. The estimated average annual net benefit of this more intensive land use is $24,006. The project works of improvement will accrue a total estimated average annual changed land use and/or management benefit of $31,085 (Supporting Data on Changed Land Use). Practically all of these land use changes are expected to be accomplished within five to seven years after the project is installed.

Although no secondary type benefits, nor incidental recreation benefits, were evaluated in monetary terms, the installation of this project will bring needed employment opportunities, additional incomes, and recreational possibilities to the watershed community. Farming is the only principal source of employment and income in the watershed area.

Additional floodwater damage reductions will be effected downstream below the evaluation floodplain area of this project. These areas include the lower floodplain portion of the McNight Creek and a sizeable portion of Tradewater River floodplain located immediately below the confluence of Buffalo Creek. An estimated total of 950 acres will receive flood stage reduction benefits not measured for evaluation of this project.

COMPARISON OF BENEFITS AND COSTS

Structural measures, including eight (8) floodwater retarding structures and stream channel improvements, will be installed at an estimated average annual cost of $28,988 and will provide a total estimated average annual primary benefit of $41,215. The benefit-cost ratio for structural measures is 1.4 to 1.0 (Table 6).

PROJECT INSTALLATION

Land Treatment Measures

The land treatment measures on private land will be installed by the landowners and/or operators during the 5-year project period in cooperation with their Soil Conservation District. The Kentucky Division of Forestry will be responsible for the installation of measures on State land. The Service will, under authority of P.L. 566 provide additional technical assistance in order to accelerate the going P.L. 46 program. The Kentucky Division of Forestry in cooperation with the U.S. Forest Service will provide technical assistance in the application of all forestry measures. Assistance in the educational phase of the program will be available through the Agricultural Extension Service of the University of Kentucky.

Structural Measures

The eight (8) floodwater retarding structures and the 73,280 linear feet of channel improvement will be installed by the Sponsoring Local Organizations, during the last four years of the project period. The Upper Tradewater River Watershed Conservancy District will award and administer all contracts and will secure, without cost to the Federal Government, all required land, easements and rights-of-way.

The Upper Tradewater River Conservancy District in accordance with the Kentucky Conservancy District Law, has the authority to (1) levy an annual tax, (2) acquire necessary land or rights-of-way by purchase, grant, bequest, or through condemnation proceedings, (3) construct, improve, operate and maintain such structures as may be necessary for the performance of any functions authorized by the Act, and (4) borrow money for the purposes of the Act and issue, negotiate and sell bonds. The Conservancy District Board has indicated that it will use these authorities to the extent necessary for the installation of the structural works of improvement.

The Service will assist the Sponsoring Local Organizations in developing plans and specifications and in preparing contracts for construction, provide installation services, and participate in the installation of the structural measures.

FINANCING PROJECT INSTALLATION

The total estimated cost of project installation is $2,052,460 and includes $1,271,100 for land treatment measures and $781,360 for structural measures (Table 1).

The land treatment measures on the cropland and grassland will be applied on individual farms by the operator and/or landowner. The forestry measures (estimated cost $24,300) will be applied on both private land and on land belonging to the State of Kentucky. The estimated cost of measures to be applied on State land is $7,100. It is anticipated that assistance toward the application of all land treatment measures on private lands will be available upon application for cost-sharing under the Agricultural Conservation Program. Technical assistance provided by the Service under P.L. 566 is $79,600 and under P.L. 46 is $17,000. The cost of technical assistance for the forestry measures is estimated at $19,100 and will be shared equally by P.L. 566 and the Kentucky Division of Forestry.

The installation cost for the structural measures to be borne by Federal funds, under P.L. 566 includes $526,430 for construction and $195,730 for installation services. Such assistance is contingent upon the appropriation of funds for this purpose. The other costs ($59,200) will be borne by the Upper Tradewater River Watershed Conservancy District and includes $53,740 for land, easements and rights-of-way and $5,460 for the administration of contracts. It is expected that tax revenues and individual donations of land, easements, or rights-of-way will be adequate to fulfill these obligations. It is not anticipated that the loan provision of the Act will be used.

PROVISION FOR OPERATION AND MAINTENANCE

The land treatment measures on private land will be operated and maintained by the landowners and/or operators of the land on which the measures are installed. The forestry measures installed on State land will be operated and maintained by the Kentucky Division of Forestry. Technical assistance on private land will be furnished by the Service and by the Kentucky Division of Forestry in cooperation with the U.S. Forest Service.

The structural measures will be operated and maintained by the Upper Tradewater River Watershed Conservancy District. The estimated average annual operation and maintenance cost for the floodwater retarding structures is $1,125 and for the channel improvement is $2,525. Included in the $2,525 are funds for maintaining the present channel capacities in those H-E reaches where no improvement is planned. Regular maintenance items include sustaining vegetative cover by fertilization, reseeding, mowing, brushing and spraying; removal of debris from emergency and principal spillway inlets and removal of debris, gravel and sand deposits in the stream channels; repair of excessive scour of stream banks and at outlets of principal and emergency spillways; repair of sloughing stream banks, and structure embankments or emergency

spillway side slopes; and similar maintenance items as needed to insure full operation of structures and channels for the evaluation period.

A representative of the Service and of the Sponsoring Local Organizations will make joint inspections annually and/or after severe storms. They will determine how the measures are functioning, what maintenance work is needed, when such work will be done and an estimate of cost.

The Upper Tradewater River Watershed Conservancy District will make adequate arrangements for the operation and maintenance of the structures and the channels. This will be accomplished by the levy of an annual tax. The anticipated revenue from this tax is more than adequate to meet this obligation.

Specific operation and maintenance agreements must be executed prior to issuance of invitations to bid.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Upper Tradewater River Watershed, Kentucky

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/		
			P.L. 566 Funds	Other	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acre	6,010		196,650	196,650
Grassland	Acre	17,970		934,450	934,450
Technical Assistance			79,600	17,000	96,600
SCS Subtotal			79,600	1,148,100	1,227,700
Forest Service					
Forest Land	Acre	2,100		24,300	24,300
Technical Assistance			9,550	9,550	19,100
FS Subtotal			9,550	33,850	43,400
TOTAL LAND TREATMENT			89,150	1,181,950	1,271,100

Continued

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Upper Tradewater River Watershed, Kentucky

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/		
			P.L. 566 Funds	Other	Total
STRUCTURAL MEASURES					
Construction					
Soil Conservation Service					
Floodwater Retarding Str.	No.	8	459,740		459,740
Stream Channel Improvement	L.Ft.	73,280	66,690		66,690
Subtotal-Construction			526,430		526,430
Installation Services					
Soil Conservation Service					
Engineering Services			116,150		116,150
Other			79,580		79,580
Subtotal-Instal. Services			195,730		195,730
Other Costs					
Soil Conservation Service					
Land, Easements & R/W				53,740	53,740
Admin. of Contracts				5,460	5,460
Subtotal-Other				59,200	59,200
TOTAL STRUCTURAL MEASURES			722,160	59,200	781,360
SUMMARY					
Subtotal SCS			801,760	1,207,300	2,009,060
Subtotal FS			9,550	33,850	43,400
TOTAL PROJECT			811,310	1,241,150	2,052,460

1/ Price base, 1963

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

(at time of work plan preparation)

Upper Tradewater River Watershed, Kentucky

Measures	Unit	Applied To Date	Total Cost (Dollars)1/
LAND TREATMENT			
Cropland:			
Contour Strip Cropping	Acre	480	3,850
Grassed Waterway	Acre	140	27,600
Diversion Construction	Foot	46,500	9,970
Terracing	Foot	129,800	7,730
Open Drains	Foot	379,900	93,120
Tile Drains	Foot	14,400	3,600
Pasture:			
Pasture Planting	Acre	3,330	160,000
Pasture & Hayland Improvement	Acre	500	18,900
Farm Ponds	No.	66	26,400
Forest Land:			
Tree Planting	Acre	385	12,700
Hydrological Cultural Operation	Acre	10	150
TOTAL	xxxx	xxxx	364,020

1/ Price base, 1963

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
Upper Tradewater River Watershed, Kentucky
(Dollars) 1/

Structure Site Number or Name	INSTALLATION COST-P.L. 566 FUNDS				INSTALLATION COST-OTHER FUNDS			Total Installation Cost
		Instal. Services			Other			
	Constr.	Engineer.	Other	Total P.L. 566	Adm. of Contracts	Easements & R/W	Total Other	
F.R.S. No. 1	88,670	18,270	13,920	120,860	800	8,820	9,620	130,480
3	65,560	14,690	10,360	90,610	700	5,420	6,120	96,730
5	49,340	10,840	7,050	67,230	700	7,730	8,430	75,660
7	67,500	15,000	10,700	93,200	900	3,500 2/	4,400	97,600
8	46,090	10,250	6,580	62,920	500	1,850	2,350	65,270
9	24,000	5,350	3,420	32,770	400	450	850	33,620
10	62,980	13,160	8,940	85,080	600	15,150	15,750	100,830
11	55,600	11,920	7,940	75,460	200	780	980	76,440
Subtotal-F.R.S.	459,740	99,480	68,910	628,130	4,800	43,700	48,500	676,630
Channel Improvement Reach I, II & III	-	-	-	-	100	1,100	1,200	1,200
IV	6,490	1,620	1,040	9,150	50	390	440	9,590
V	-	-	-	-	50	220	270	270
VI	1,620	400	260	2,280	50	250	300	2,580
VII	7,360	1,840	1,180	10,380	50	1,010	1,060	11,440
VIII	11,780	2,950	1,880	16,610	70	1,580	1,650	18,260
IX	1,750	440	280	2,470	60	1,230	1,290	3,760
X	12,600	3,150	2,020	17,770	80	1,520	1,600	19,370
XI	6,630	1,660	1,060	9,350	70	1,190	1,260	10,610
XII	18,460	4,610	2,950	26,020	80	1,550	1,630	27,650
Subtotal-Chan. Imp.	66,690	16,670	10,670	94,030	660	10,040	10,700	104,730
GRAND TOTAL	526,430	116,150	79,580	722,160	5,460	53,740	59,200	781,360

1/ Price base, 1963
2/ Includes alteration of road and bridge, $600

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TABLE 3 - STRUCTURE DATA
FLOODWATER RETARDING STRUCTURES
UPPER TRADEWATER RIVER WATERSHED, KENTUCKY

Item	Unit	STRUCTURE NUMBER				
		1	3	5	7	8
Drainage Area 1/	sq.mi.	10.93	8.43	9.53	6.17	3.79
Time of Concentration 1/	hour	1.76	1.57	1.95	1.95	1.72
Ave. Curve No. Cond. II 1/		74	74	77	74	74
Storage Capacity						
Sediment 1/						
Detention Pool	ac.ft.	75	62	87	44	33
Sediment Pool	ac.ft.	415	352	487	252	189
1st 50 year	ac.ft.	245	207	287	148	111
Floodwater	ac.ft.	1488	1215	1627	795	490
Total	ac.ft.	1978	1629	2201	1091	712
Surface Area						
Sediment Pool	acre	76.5	51.0	122.0	35.0	24.8
Floodwater Pool	acre	167.0	128.0	215.0	74.0	50.0
Volume of Fill	cu.yd.	73838	64092	28400	58247	33082
Elevation Top of Dam	foot	520.5	485.4	443.1	505.7	471.2
Maximum Height of Dam	foot	34.2	42.2	28.6	41.6	39.8
Emergency Spillway						
Crest Elevation	foot	514.7	481.4	438.1	499.7	466.2
Bottom Width	foot	20	62	23.5	21	23
Maximum Capacity	c.f.s.	770	1260	720	875	710
Type		rock	rock	rock	rock	rock
Percent Chance of Use		4	4	4	4-	4-
Emergency Spillway Hyd.		Does not produce ES flow				
Storm Rainfall 1/	inch	4.86	4.92	4.92	4.92	4.92
Storm Runoff 1/	inch	2.25	2.30	2.55	2.30	2.30
Freeboard Hydrograph						
Storm rainfall 1/	inch	7.60	7.68	7.68	7.68	7.68
Storm runoff 1/	inch	4.57	4.64	4.99	4.64	4.64
Velocity of Flow (V_c)	f.p.s.	10.0	8.7	8.0	11.0	9.9
Discharge Rate	c.f.s.	540	1260	330	875	710
Max. w. s. elevation	foot	520.0	485.4	441.6	505.7	471.2
Spillway Storage	ac.ft.	972	571	779	484	280
Principal Spillway						
Storm Duration	hour	60	60	72	6	6
Storm Rainfall	inch	7.06	7.06	7.38	4.47	4.47
Storm Runoff	inch	4.09	4.09	4.71	2.61	2.61
Crest Elevation	foot	501.9	466.5	428.0	484.5	452.1
Capacity (max.)	c.f.s.	220	160	160	160	100
Conduit Diameter	inch	42	36	36	36	30
Capacity Equivalent						
Sediment Volume	inch	0.71	0.92	1.13	0.90	1.10
Detention Volume	inch	2.55	2.70	3.20	2.42	2.42
Spillway Storage	inch	1.79	1.27	1.51	1.47	1.38
Class of Structure		a	a	a	a	a

1/ Adequate for final design

Continued

TABLE 3 - STRUCTURE DATA
FLOODWATER RETARDING STRUCTURES
UPPER TRADEWATER RIVER WATERSHED, KENTUCKY

Item	Unit	STRUCTURE NUMBER 9	10	11	Total
Drainage Area 1/	sq.mi.	2.50	8.81	2.83	52.99
Time of Concentration 1/	hour	0.85	1.84	1.00	
Ave. Curve No. Cond II 1/		69	75	75	
Storage Capacity					
Sediment 1/					
Detention Pool	ac.ft.	2	64	20	387
Sediment Pool	ac.ft.	11	365	118	2,189
1st 50 year	ac.ft.	7	215	70	1,290
Floodwater	ac.ft.	272	1180	392	7,459
Total	ac.ft.	285	1609	530	10,035
Surface Area					
Sediment Pool	acre	4.0	81.0	18.2	412.5
Floodwater Pool	acre	30.0	161.0	38.5	863.5
Volume of Fill	cu.yd.	17253	44025	53000	371,937
Elevation Top of Dam	foot	486.0	467.1	464.2	
Maximum Height of Dam	foot	33.9	30.3	33.2	
Emergency Spillway					
Crest Elevation	foot	482.0	461.7	459.4	
Bottom Width	foot	20	20	20	
Maximum Capacity	c.f.s.	400	693	560	
Type		rock	rock	rock	
Chance of Use	percent	4-	4-	4	
Emergency Spillway Hyd.		Does not produce ES flow			
Storm Rainfall 1/	inch	4.92	4.92	4.92	
Storm Runoff 1/	inch	1.89	2.38	2.38	
Freeboard Hydrograph					
Storm Rainfall 1/	inch	7.68	7.68	7.68	
Storm Runoff 1/	inch	4.08	4.76	4.76	
Velocity of Flow (V_c)	f.p.s.	8.7	9.5	9.7	
Discharge Rate	c.f.s.	400	520	560	
Max. w. s. elevation	foot	486.0	467.1	464.2	
Spillway Storage	ac.ft.	155.4	861	205	
Principal Spillway					
Storm Duration	hour	6	6	60	
Storm Rainfall	inch	4.47	4.47	7.06	
Storm Runoff	inch	2.19	2.70	4.20	
Crest Elevation	foot	464.0	451.4	445.6	
Capacity (max.)	c.f.s.	60	220	60	
Conduit diameter	inch	24	42	24	
Capacity Equivalent					
Sediment Volume	inch	.10	.91	.91	
Detention Volume	inch	2.04	2.51	2.60	
Spillway Storage	inch	1.17	1.47	1.36	
Class of Structure		a	a	a	

1/ Adequate for final design

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TABLE 3A - STRUCTURE DATA
CHANNELS FOR FLOOD PREVENTION
UPPER TRADEWATER RIVER WATERSHED, KENTUCKY

Channel Designation	Reach Stations		1/ Watershed Area	Present Cond.		Planned Improvement						
	Head	Foot		Capacity	"n"	Reqd. Capacity	"n"	Bottom Width	Depth	Grade	Velocity	Volume of Excavation
	100 ft.	100 ft.	sq.mi.	cfs		cfs		ft.	ft.	pct.	fps	cu.yds.
R-IV			5.99									
B-3 to V-20	250	294				900						Clear & Snag
V-20 to C-21	294	310		571	.055	900	.045	28	9	.0005	2.48	6680
C-21 to C-22	310	325		643	.055	900	.045	22	10	.0005	2.54	5710
R-VI			8.00									
V-22 to V-25	325	331		900	.055	900	.045	22	10	.0006	2.54	2800
V-25 to C-26	331	346		984		900						Clear & Snag
C-26 to V-30	346	406		1001		900						
R-VII			11.29									
V-30 to C-31	406	425				900	.045	30	9	.0005	2.52	11240
C-31 to C-34	425	482		1049		900						
C-34 to V-35	482	518		877	.055	900	.050					Clear & Snag
V-35 to C-38	518	594		1145		900						
C-38 to V-39	594	620		870		900						Clear & Snag
V-39 to C-40	620	643		1198		900						
R-VIII A			0.51									
B-2 to F-4	16	42				250						
R-VIII B			1.46									
F-4 to C-41	42	60		527	.055	400	.050					Clear & Snag
C-41 to V-42	60	67.5		390		400	.045	14	8	.0008	3.28	930
V-42 to C-43	67.5	96		731		400						
C-43 to C-44	96	110		393	.055	400	.035	14	8	.0008	3.44	1150
R-VIII D			3.33									
C-44 to B-6	110	120				620		14	8	.0008	3.44	Clear & Snag
B-6 to C-46	120	136		445	.055	620	.035	18	6.4	.0008	3.27	Clear & Snag
C-46 to Jct.	136	176				620						

1/ Average uncontrolled drainage area for reach

(Continued)

TABLE 3A - STRUCTURE DATA
CHANNELS FOR FLOOD PREVENTION
UPPER TRADEWATER RIVER WATERSHED, KENTUCKY

Channel Designation	Reach Stations		1/ Watershed Area	Present Cond.		Planned Improvement						
	Head	Foot		Capacity	"n"	Reqd. Capacity	"n"	Bottom Width	Depth	Grade	Velocity	Volume of Excavation
	100 ft.	100 ft.	sq.mi.	cfs		cfs		ft.	ft.	pct.	fps	cu.yds.
R-IX			18.16									
C-52 to V-53	716	728				1300						Clear & Snag
C-56 to C-58	807	849				1300						Clear & Snag
R-X a			0.51									
V-62 to C-66	17.5	44.5		208	.065	260	.050					Clear & Snag
C-66 to V-67	44.5	62		272	.065	260	.050	16	7	.001	2.84	4250
R-X B			3.24									
V-67 to C-68	62	77.5		165	.065	500	.045	16	7	.001	2.84	4280
C-68 to B-9	77.5	90			.065	500	.035	18	8			670
B-9 to C-69	90	92		230	.060	500	.035	21	7	.00035	2.25	2340
C-69 to V-70	92	99.0		238	.060	500	.035	16	8	.00035	2.24	5370
V-70 to V-71	99	110.5			.060	500	.035	16	8	.00035	2.24	4349
V-71 to C-72	110.5	122			.060	500	.035	8	10	.00035	2.38	3440
C-72 to C-73	122	128			.060	500	.035	12	6	.00035	2.50	2150
C-73 to Jct.	128	130			.060	500	.035	12	6	.00035	2.50	148
R-XI			24.50									
C-59 to C-61	866	907										Clear & Snag
C-61 to V-74	907	916		1156	.050	1700	.035	24	14	.00035	3.18	950
V-74 to C-75	916	938		1807	.050	1700	.035	24	14	.00035	3.18	2320
C-75 to C-76	938	960		1221	.050	1700	.035	24	13	.00035	3.18	2690
C-76 to C-77	960	992		1399	.050	1700	.035	24	13	.00035	3.18	3910
C-77 to V-78	992	1014		845	.050	1700	.035	40	13	.00015	2.23	4110
V-78 to C-79	1014	1022		845	.050	1500	.035	35	13	.00015	2.30	3420
C-79 to C-80	1022	1026		883	.055	1500	.035	35	13	.00015	2.30	5990

1/ Average uncontrolled drainage area for reach

(Continued)

TABLE 3A - STRUCTURE DATA
CHANNELS FOR FLOOD PREVENTION
UPPER TRADEWATER RIVER WATERSHED, KENTUCKY

Channel Designation	Reach Stations		1/ Watershed Area	Present Cond.		Planned Improvement						
	Head	Foot		Capacity	"n"	Reqd. Capacity	"n"	Bottom Width	Depth	Grade	Velocity	Volume of Excavation
	100 ft.	100 ft.	sq.mi.	cfs		cfs		ft.	ft.	pct.	fps	cu.yds.
R-XII			28.88									
C-80 to C-82	1026	1038		977	.055	1500	.035	35	13	.00015	2.19	17430
C-82 to V-83	1038	1051		808	.055	1500	.035	35	13	.00015	2.19	6950
V-83 to V-84	1051	1075		1051	.055	1500	.035	35	13	.00015	2.19	9160
V-84 to Br.	1075	1077		1051	.055	1500	.035	30	14	.00015	2.23	630
Br. to V-85	1077	1082		817	.055	1500	.035	30	14	.00015	2.23	1470
V-85 to V-86	1082	1106		896	.055	1500	.035	30	14	.00015	2.23	2890
V-86 to V-87	1106	1119		933	.055	1500	.035	30	14	.00015	2.19	170

1/ Average uncontrolled drainage area for reach

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TABLE 4 - ANNUAL COST

Upper Tradewater River Watershed, Kentucky
(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Other Economic Cost	Total
Unit 1: FRS Nos. 1, 3, 5, 7, 8, 9, 10 and 11 with 73,280 L. Ft. Channel Improvement	24,784	3,650	554	28,988
TOTAL	24,784	3,650	554	28,988

1/ Price base, 1963. Amortization period, 100 years. Interest rate, 3 percent.
2/ Price base, projected long-term.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Upper Tradewater River Watershed, Kentucky
(Dollars) 1/

Item	Estimated Average Annual Damage : Without Project	: With Project	: Damage Reduction Benefits
Floodwater and Sediment			
Crops and Pasture	9,582	1,895	7,687
Other Agricultural	1,501	286	1,215
Non-Agricultural:			
Roads and Bridges	1,006	95	911
Subtotal	12,089	2,276	9,813
Indirect	1,212	226	986
TOTAL	13,301	2,502	10,799

1/ Price base, projected long-term

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES
Upper Tradewater River Watershed, Kentucky
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/				Average Annual Cost 2/	Benefit Cost Ratio
	Flood Prevention					
	Damage Reduction	More Intensive Land Use	Changed Land Use	Total		
Unit No. 1: FRS Nos. 1,3, 5, 7, 8, 9, 10 and 11 with 73,280 L. Ft. Channel Improvement	10,130	24,006	7,079	41,215	28,988	1.4:1.0
GRAND TOTAL	10,130 3/	24,006	7,079	41,215	28,988	1.4:1.0

1/ Price base, projected long-term
2/ Price bases: installation cost, 1963; operation and maintenance, and other economic costs, projected long-term
3/ In addition it is estimated that land treatment measures will provide floodwater and sediment damage reduction benefits of $669 annually

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TABLE 7 - CONSTRUCTION UNITS

Upper Tradewater River Watershed, Kentucky

(Dollars) 1/

Measures in Construction Unit	Annual Benefit	Annual Cost
Unit 1: FRS No. 1	9,196	4,394
Unit 2: FRS No. 3	5,234	3,265
Unit 3: FRS No. 5	3,378	2,730
Unit 4: FRS No. 7	4,337	3,291
Unit 5: FRS No. 10	5,119	3,378

1/ Price bases: projected long-term for structural benefits, operation and maintenance, and other economic costs; current, 1963, for structural installation costs.

INVESTIGATIONS AND ANALYSES

Land Use and Treatment Needs

The capabilities and limiting characteristics of dominant soil types, and a general present land use pattern for the watershed (more detail for each structure drainage area), were extracted from basic farm plans and expanded to account for the full acreage.

Future land use and treatment needs were based on the use of the land within its capabilities and treatment within the practical limits of landowners, to aid the retardation of erosion and storm peak flows.

The future total land treatment needs were determined for the watershed. The Sponsoring Local Organizations determined the amount of these measures which they expect to be completed during the five year project installation period.

Hydraulic and Hydrologic

The frequency-storm rainfall relationship for design of structural measures and damage appraisal was based on U.S. Weather Bureau Technical Paper Number 40, for six-hour duration storms. Partial duration series corrections were applied to the values read from Technical Paper Number 40 to determine the annual series relationship.

Frequency-years	Storm Rainfall-Inches
100	4.92
50	4.48
25	4.06
10	3.48
5	2.99
2	2.26

Records for two U.S. Geological Survey stream gaging stations were studied to determine relationships between cropping season series and annual series peak discharges. Stations studied were: East Fork Pond River near Apex, 194 square miles, water years 1941 through 1962 and Tradewater River at Olney, 255 square miles, water years, 1938 through 1962. The cropping season considered is from the first of May to mid-November. Final values of direct runoff were determined from the storm rainfall amounts by the method in Chapter 10 of the SCS Hydrology Handbook. Antecedent moisture condition II was used for the cropping season series. The annual series was based on a runoff curve number corresponding to an

antecedent moisture condition midway between the II and III conditions. The relationships between the two series used agrees with the results of the stream gage studies.

Soil-cover complexes for the floodwater retarding structures were determined on a sub-watershed basis and are adequate for final design.

The main stem and major tributaries were divided into seventeen reaches, based on hydraulic and economic considerations. Fifty-two valley, fifty-six channel, nine structure and nine bridge cross-sections were surveyed by stadia. Vertical control for all cross-sections was from a continuous bench level survey referenced to mean sea level datum.

Rating curves, based on steady, uniform flow conditions, were computed for each cross section by Manning's Formula. The variation of roughness coefficient with hydraulic radius, the difference between floodplain and channel lengths, division into segments of similar hydraulic properties were accounted for in the computations. For each damage appraisal reach, a composite rating curve was drawn, using all channel and valley cross-sections in the reach and a stage-area flooded relationship developed. The total area flooded in each reach was adjusted to that area determined by planimetering the floodplain area, as delineated on aerial photographs, using high water marks obtained in the field.

The watershed was divided into twenty-eight sub-watersheds, and triangular hydrographs developed for each sub-watershed. The peak rates were determined by the procedure in E and W P Unit Hydrology Memorandum No. 4. A unit volume of one inch of direct runoff was floodrouted by the Improved Coefficient Method to establish peak discharge-runoff volume relationships for present condition damage appraisal. For future conditions, the hydrographs representing the areas controlled by floodwater retarding structures were modified to reflect their passage through the dams. One and two inch volumes of direct runoff were routed to determine the "with structures" peak discharge-runoff volume relationship. The travel times used for the routings were weighted to reflect the variation of average velocity with discharge. No routings were performed for the "with channel improvement" condition since the work required to accomplish the design level of protection (five-year, cropping season) would not affect the floodrouting travel times significantly.

Water surface profiles (Leach Method) were computed through the last reach of the watershed to establish a starting elevation for preliminary design of the channel improvement (Elevation 408.4, mean sea level, at cross section C-87).

The seasonal distribution of flood events was determined by an analysis of three stream gage records: East Fork Pond River near Apex, East Fork Clarks River near Benton and Mud River near Lewisburg. The percentages were weighted by number and size of events.

Appraisal of floodwater damages to crops and pasture were based on the cropping season series; damages to roads and bridges and other agricultural were based on the annual series.

Hydrologic design criteria for preliminary design of floodwater retarding structures was based on present condition runoff curve numbers. All structures were designated as "class a" structure sites.

Engineering

U.S.G.S. topographic maps at a scale of 1:24000, having a 10-foot contour interval, were used to determine the drainage area of the watershed, sub-watersheds and the areas used to develop stage-surface area and stage-storage curves. Approximate methods were used to arrive at an estimated structure cost to be used in benefit-cost ratio study. Rock cut cost of emergency spillway versus embankment cost curves were developed to arrive at the most economical structure height. A centerline profile of each site was taken by stadia survey. The vertical control for all field surveys was by mean sea level datum.

Preliminary design based on criteria and procedures contained in SCS Engineering Memorandums 27 and 31, SCS Technical Release No. 2 and No. 10, and Section 3.21 of the Hydrology Guide were prepared for the floodwater retarding structures. Two principal spillway hydrographs were routed through all structures to determine the minimum volume of principal spillway storage to meet the SCS State and National criteria.

Fifty year, six hour point rainfall was used in determination of minimum principal spillway storage for floodwater retarding structures Nos. 7, 8, 9 and 10. A sixty hour duration storm was used in determination of the minimum principal spillway storage for structures Nos. 1, 3 and 11, and a seventy-two hour duration storm was used for Structure No. 5.

The proposed channel improvement, in conjunction with the land treatment and floodwater retardation programs, was designed to contain within bank, through cropping season, the peak discharge of a five-year frequency storm. The study was made from the 52 valley sections, 56 channel sections and 9 bridge sections made in the field, positions being determined by inspecting U.S.G.S. topographic maps.

Valley and channel slopes were obtained by use of field surveyed cross sections and distances measured from the topographic maps.

The hydraulic gradient was designed to meet the elevation of 5-year frequency backwater elevation at cross-section C-87 (408.4 feet mean sea level).

Cost estimates were based on current construction unit prices, and were approved by the State Conservation Engineer and the Construction Engineer.

Geologic

Field studies were made throughout the watershed of rock exposures in roadcuts, stream channels, or where outcrop occurred normally. These investigations were made in order to become familiar with the general geology of the watershed. U.S.G.S. 7.5 minute series topographic maps were used as working base maps. These maps were supplemented by 1959 aerial photographs used for stereoscopic studies. Reference material used included the following: Sutton, A. H., 1928, Map of Areal and Structural Geology of Christian County, Kentucky; Kentucky Geol. Survey, Ser. 6, Scale 1:62,500; Lambert, T. W., Brown, R.F., 1963, Hydrologic Investigations Atlas HA-34; U.S.Geological Survey; McFarlan, A. C., 1950, Geology of Kentucky, the University of Kentucky. Geologic investigations were concentrated in the immediate vicinities of proposed floodwater retarding structure sites. These preliminary investigations were made to determine the geologic conditions and character of materials at the site. These preliminary investigations will also serve to determine the need for future detailed investigations.

The northern half of the watershed is located in the Western Coal Fields and the southern half in the Mississippian plateau physiographic area. Six of the proposed floodwater retarding structure sites are located in the southern half of the watershed within the Mississippian plateau. Formations exposed here are limestones, sandstones, and shales of the Chester series.

Two of the proposed floodwater retarding structure sites are located within the Western Coal Fields. The rock formations in the vicinity of the proposed dams are sandstones and shales of lower Pennsylvanian age.

F.R.S. No. 1 is located on the upper reach of Tradewater River. Surface examinations were made of rock exposures in the site vicinity. Hand auger borings were made along the proposed emergency spillway to determine the depth of soil over rock and the type of soil according

to the unified soils classification system. The depth to bedrock in the valley could not be determined by hand auger borings or by mapping rock exposures. This information will be obtained during the detailed geologic investigation. A limestone exposure was found on the right abutment about midway between the toe of the slope and the emergency spillway. It appears to be one of the limestones of the Chester series. The attitude of the rock outcrops examined in the vicinity of the site appears to be essentially horizontal.

The alluvial material in the bottomlands appears to be predominantly low plastic silts with some coarse sand and fine gravel. Clays may be obtained from the slopes.

F.R.S. No. 3 is located on Brushy Fork. Borings were made in the proposed emergency spillway area with a Mobile B-27 drill to determine depth and type of soil. The holes were logged in accordance with the unified soils classification system. Surface investigations indicate both abutments will be in sandstone.

F.R.S. No. 5 is located on Castleberry Creek. Surface investigations were made in the vicinity of the proposed dam site. Sandstone and shale formations outcrop near the base of the right abutment, below the emergency spillway location. Hand auger borings in the emergency spillway location encountered shale at about 3-1/2 feet.

F.R.S. No. 7 is located on Dripping Springs Branch. Surface examinations were made of the site and borings were made in the vicinity of the emergency spillway to provide the design engineer with a rock line. The rock formation beneath the soil on the abutment areas is limestone. The stream is flowing on sandstone bedrock. Rock exposures examined in a roadcut near the site revealed alternating limestone, sandstone and shale.

F.R.S. No. 8 is located on Whitehorn Creek. Hand auger borings indicate there is about 2-1/2 feet of clay soil overlying shale in the proposed emergency spillway area. The soil is fairly shallow on both abutments. A steeply dipping buff-colored sandstone formation is exposed on the right abutment area. A short distance upstream there is an exposure of dense grey chrystalline limestone with a vertical dip. A fault appears to cross the proposed pool area. Since this structure will be a single purpose, low hazard flood control dam, water holding capacity of a permanent pool is not essential. Since the fault does not appear to cross the constructed embankment area, its presence should not affect structural design. Detailed studies should be made during the operations stage. This should include a core drilling program along the centerline of the foundation for correlation purposes.

F.R.S. No. 9 is located within the Pennyrile Forest State Park on a tributary of Sandlick Creek. The valley is very narrow, and the abutments steep with a shallow mantle of soil over rock. In the beginning there was some concern as to the availability of borrow material for fill construction. The emergency spillway area was investigated with a Mobile B-27 power auger. There is a depth of from 9 to 13 feet of low plastic silts to high plastic clays which may be used in the fill. Adequate borrow will be available from the emergency spillway and the sediment pool areas.

The proposed site for F.R.S. No. 10 is located on Sandlick Creek. The soils are buff colored sandy silts overlying red sandstone. The depth of soil on the abutment areas ranges from 2 to 3 feet. Borrow material is available in sufficient quantity from the sediment pool area. Clay materials will have to be obtained from the higher slopes. No geologic conditions were encountered which would adversely affect the structural design.

The proposed site location for F.R.S. No. 11 is on Tugler Creek. Hand auger borings in the proposed emergency spillway encountered sandstone bedrock beneath 3-1/2 feet of sandy silts. There are no rock exposures in the channel. Borrow material will be available in sufficient quantity from the sediment pool area.

Prior to final design additional geologic investigations will be made at all of the proposed floodwater retarding structure sites. Enough test holes will be bored in order to identify, delineate, and correlate the underlying strata beneath the dam foundation and principal spillway. Some additional drilling may also be needed in the emergency spillway areas of some of the sites. Soil samples will be collected of embankment borrow materials for the desired soils laboratory analysis. The depth to bedrock is expected to be fairly shallow beneath the structure embankments. If investigations reveal deep valley soil deposits, undisturbed samples of foundation materials will need to be obtained. Most of the sites are easily accessible to Service owned drilling equipment.

Sediment Storage Requirements

Reservoir sediment surveys of Lake Tandy, located in an adjacent watershed, were used as a basis for soil loss rates. The present land use of each structure drainage area was obtained for comparison purposes to Lake Tandy drainage area. Some adjustments were made where it appeared that land use and land treatments were different.

The drainage area of one structure (F.R.S. No. 5) contains some strip mines, both active and abandoned. This is the most

northerly structure drainage area, and the only one with anticipated future mining operations. The drainage areas of the other sites to the south have a greater depth of overburden which makes strip mining operations unprofitable. Soil loss rates from the Beaver Creek Basin studies - Kentucky, and studies made by SCS technicians on Clear Creek Watershed, Kentucky were used for predicting sediment yields from strip mine and potential strip mines.

The drainage area of F.R.S. No. 9 is located within the Pennyrile State Forest. The land use is woodland with the exception of 25 acres on the watershed divide. The cover conditions are very good. Soil loss rates from the Cumberland National Forest (Beaver Creek Basin studies - Kentucky) were used to predict sediment yield to this site.

The sediment storage requirements used for planning purposes will also be used for final design. They are adequate for 100-year sediment yield.

Erosion and Sedimentation

Stereoscopic studies were made of aerial photographs (1959 flight) of the entire watershed prior to field investigations. Special attention was given the structure site drainage areas for gullied areas or areas of intensive sheet erosion. The floodplain areas were studied to locate scour channels and areas of infertile overwash. These areas were marked for field studies. Aerial photo studies revealed strip mine areas and they were later individually field checked to determine if they were a critical sediment source potential.

Areas of bottomland damages, observed by the field survey crew, were field checked. The local Soil Conservation Service technicians were consulted concerning critical upland areas and areas of bottomland damages. Areas of new strip mines, not shown on aerial photographs, were located this way.

Field investigations indicate the rate of sheet erosion in the upland areas to be moderate; the rate of gully erosion low; and sediment and scour damages in the bottomland areas negligible. The future sediment yield from strip mine areas (principally in the Morgan and Castleberry Creek sub-watersheds), will be limited to the outer perimeter of the spoil banks while vegetation is being established.

Economic

Basic economic data were obtained in the field by interview of approximately 20 percent of the floodplain farmers, public officials, and professional agricultural technicians, and first-hand observations and recordings made in the study area. Review of several published studies and official records relating to the economy of the area was made. This collection of information was assembled, and together with similar planning data from an adjacent watershed, West Fork of Pond River, was compared and appraised as to applicability, and summarized to arrive at workable representative values. Existing floodplain conditions and reasonable expected developments for similar evaluation reaches were determined from these sources, consisting of: (1) without project land use rotations and average flood-free yields, (2) typical crop production practices, (3) anticipated with project land use rotations and average flood-free yields, (4) intensity ranges of land use probabilities based on soils capability classifications, and (5) other related economic information essential to the appraisal of watershed damages and the estimation of project benefits in terms of monetary values.

Estimates of damage of floodplain crops and pasture were developed from (1) damageable values per composite acre by size of flood, (2) stage-area-damage relationships, (3) flooding recurrence and duration adjustments where applicable, and (4) distribution of largest floods by months during the growing season. Estimated crop and pasture damages by depths per composite acre of similar evaluation reaches were incorporated with hydrologic determinations of flooding, by plotting the respective volume of damages graphically for the 100, 25, 10, 5, 3, 2 and 1.5 year frequency floods against percent probability of occurrence. The measured area beneath each curve graphically representing the average annual damage for each condition, the difference between the damages before and after project measures were assigned as floodwater damage reduction benefits to those measures.

Estimates of other agricultural floodplain damages and benefits were determined similarly as described for crops and pasture, with these exceptions: (1) damageable values for the large (25 to 50 year), medium (10 to 15 year), and small (annual to 2 year) floods on a per-acre basis were incorporated with hydrologic determinations of flooding for the respective frequency probabilities, (2) annual damages rather than cropping season damages were evaluated, and (3) the largest flood each year being the most damaging, with adjustment only for recurrent damages.

State and county highway and road damages and benefits were determined from information obtained for the evaluation of East

Fork and West Fork of Pond River Watersheds as applied to the points of similar damages in this watershed. Average annual floodwater damages were developed by relating the estimated amounts of repair and maintenance costs applicable to the large, medium and small size floods and applying the same procedure as described for other agricultural damages and benefits.

The majority of floodplain farmers are fully aware of the relatively low intensity of farming in much of the floodplain at the present time. They are primarily concerned about the more frequent floods that are preventing them from exercising both management and land use intensities more fully within the inherent capabilities of the soils of the floodplain areas. Their indicated intentions are to farm the existing cropland areas more intensively that are afforded a level of protection with the project whereby damaging floods no longer occur on the average more often than once in three years. These areas are presently flooding on the average more often than once in three years during the cropping season months and, as a result, the intensity of farming is generally lower than that of most of the adjacent areas of cropland being flooded less often than once in three years. The farmers also indicate practical expectations of converting to cropland use certain portions of existing woodland and other non-cropland areas of the floodplain which were being used for cropland in fairly recent years. These conversions will be made where damaging floods no longer occur on the average more often than once in five years after the project is installed, upon areas that are presently flooding on the average more often than once in five years.

Collectively, as a group, the floodplain farmers have the necessary resource capabilities to carry out their intended changes in land use and management within a reasonable length of time after the project is installed. Their stated intentions are supported by examples on alluvial floodplain lands in this watershed which without project now have similar levels of flooding, and similar soils and other conditions. The benefits expected to come about after the project is installed were discounted for lag in accrual. Discounting factors were based on 4 percent interest rate.

Current production costs to farmers were converted to projected long-term prices, and were based on (1) recent purchasing experiences and records of farmers in the watershed, (2) records of local agricultural agencies and business establishments, (3) similar data collected for adjacent watersheds recently planned, (4) farming custom rates as published and periodically revised by the staff of the University of Kentucky Agricultural Experiment Station, and (5) data furnished by the E&WP Unit of the Service.

SUPPORTING DATA ON CHANGED AGRICULTURAL LAND USE
Upper Tradewater River Watershed, Kentucky
(Average Annual Basis)

WITHOUT PROJECT CONDITIONS				WITH PROJECT CONDITIONS After More Intensive Land Use			
Land Use	Acres	Flood-Free Yield	Net Return (Dollars)[1]	Land Use	Acres	Flood-Free Yield	Net Return (Dollars)[1]
Corn	647	52 bu.	24,068	Corn	968	71 bu.	53,724
Tobacco (Burley)	xxx	xxx	xxx	Tobacco (Burley)	31	550 lb.[2]	3,410
Lespedeza Hay	267	1.5 T.	2,480	Lespedeza Hay	122	1.8 T.	1,598
Mixed Hay	189	1.8 T.	2,063	Mixed Hay	137	2.5 T.	2,672
Soybean Hay	66	3.1 T.	1,328	Soybean Hay	96	3.8 T.	2,760
Pasture	146	192 cpd	4,058	Pasture	157	224 cpd	5,290
Idle (Brushy)	196	[3]	98	Idle (Brushy)	xxx	xxx	xxx
TOTAL	1,511	xxx	34,095		1,511	xxx	69,454

Increased Net Return, With Project	35,359
Less Development costs (associated costs)[4]	855
Less Discount for time lag in accrual of benefits	1,282
Less floodwater damage to higher value crops	2,137
AVERAGE ANNUAL NET BENEFIT [5]	31,085

1/ Price base, projected long-term
2/ Represents average yield per acre increase moving upland acreages to floodplain
3/ Estimated overall average net return of $0.50 per acre per year
4/ Amortized at 4 percent interest rate
5/ Benefits: Land Use Conversions $ 7,079
More Intensive Land Use 24,006

April 1964

All project benefits and operation and maintenance costs were based on long-term projection indices of prices received and paid. These indices are determined and published by the U.S.D.A. Agricultural Marketing Service and Agricultural Research Service dated September 1957, supplemented March 1962.

Construction costs for 1963 were used in estimating contract costs for structural measures. A contingency allowance of 12 percent of the estimated contract cost is included in the construction cost estimates. All federal costs and local costs considered eligible for long-term loans were amortized at 3.0 percent interest rate. Associated costs were amortized, based upon a 4 percent interest rate.

Estimates of easement and rights-of-way values were determined by: (1) measuring the structure site, sediment pool, and temporary flood pool of each floodwater retarding structure as delineated on topographic map, (2) similar measurements of areas required for channel improvement as determined from the existing stream channel and the design channel, (3) determination of the extent and amount of alteration costs involved in easement cost items including bridges, roads, and farm improvements, (4) the application of per acre values of the various types of land involved as appraised by the Local Sponsoring Organizations with final concurrence by the Service.

Other economic costs for land included in the easements and rights-of-way of structural measures were based on capitalized productivity values as indicated by present land use and net income.

All structural measures were tested for economic justification as: (1) an individual structural unit functioning independently or (2) an added incremental structural unit functioning inter-dependently with other structural measure(s) or (3) an alternate unit, singly or in combination with other structural measures, for determining the least combination of structural measures in a system to obtain the desired and justifiable level of protection. The proposed structural measures (floodwater retarding structures and channel improvement) were evaluated on the basis of the agreed upon five-year level of protection, and it was determined that this agreed on level of protection could not be achieved by floodwater retardation alone.

Forestry

Investigations and analyses were made and measures to be applied in the watershed were developed by the Kentucky Division of Forestry in cooperation with the U.S. Forest Service.

Information on the present hydrologic condition of the forest land was collected in a series of field plots, selected systematically, where measurements of litter, humus, soil type, and other hydrologic factors were recorded.

The future hydrologic condition of the forest land was determined by evaluating the effect of the recommended program on the present woodland area.

Biologic

Representatives of the Kentucky Department of Fish and Wildlife Resources, the U.S. Fish and Wildlife Service and the U.S. Soil Conservation Service made a study of the watershed to determine the present status of its fish and wildlife resources, whether or not the proposed works of improvement would cause damage, and the potentiality for improving environmental conditions.

Hunting, fishing, or trapping pressure was rated as low, medium, or high, in order to assess the value of the existing fish and wildlife resources. On two occasions it was necessary to use a combination of these terms. On the basis of this method of rating, hunting pressure on rabbits, quail, both gray and fox squirrels, and deer, was found to be high. It was considered medium on raccoons, and low on mourning doves, opossums, skunks, groundhogs, red foxes, and crows. Trapping pressure on mink and muskrats was rated between low and medium. Fishing pressure on all kinds of fish was rated low in streams and medium in farm ponds. Ducks are hunted only when they are present in significant numbers.

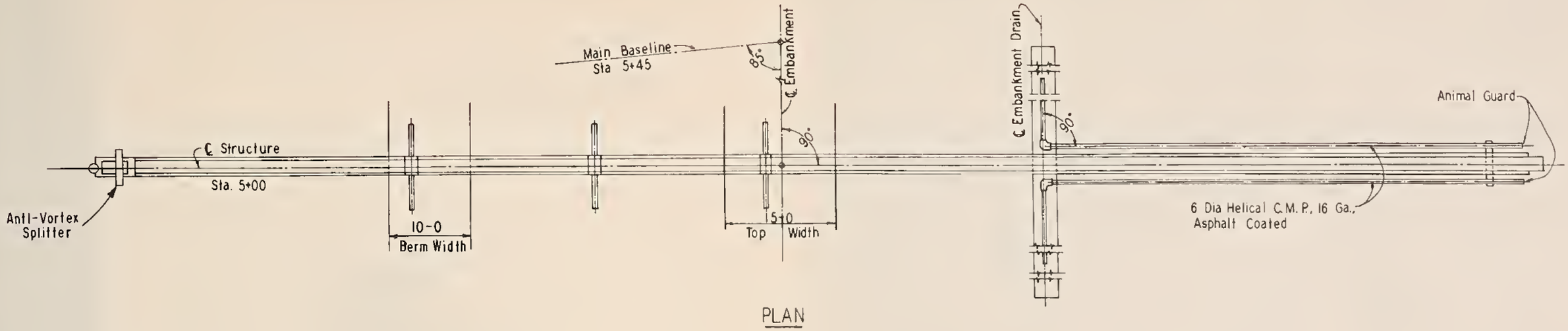
The quality of the fishery in that reach of the Tradewater River and its tributaries encompassed by the watershed project was rated as poor to fair. This was done using a rating system in which excellent, good, fair, and poor were the descriptive terms. The kinds of fish taken belong to the rough and pan categories and include bullheads, carp, suckers, bluegill and green sunfish. There is no known instance in which bass or crappie have been taken.

The results of this survey indicate that the project will probably have both positive and negative effects upon the fish and wildlife resources of the area.

Among the possible benefits will be the lessening of losses to nesting wildlife in downstream bottomland areas because of reduced flood crests, the providing of opportunities for establishing sport fishing in reservoirs created by floodwater retarding structures, and the providing of resting places for migrating waterfowl in these same reservoirs.

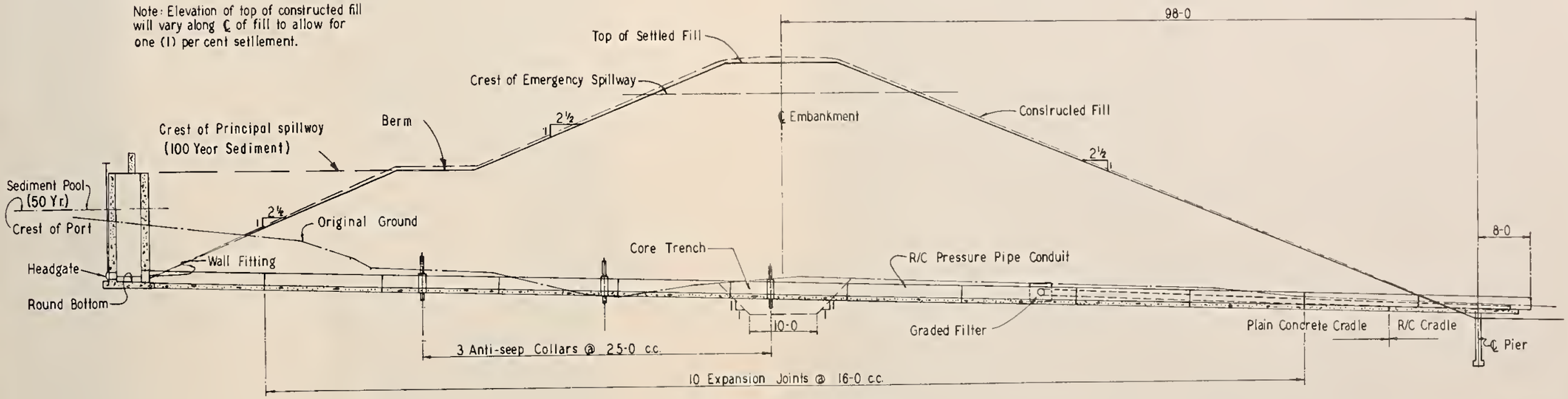
There will probably be adverse effects upon the stream fishery because of the proposed channel improvement work; upon furbearers, squirrels, and possibly nesting wood ducks because of the removal of streambank vegetation; and upon upland game and non-game species because of the projected land use conversions, if those conversions actually come about.

The best opportunity for enhancing conditions for fish and wildlife probably lies in encouraging individual landowners to consider establishing income-producing recreation enterprises involving these resources. In this way, landowners would be provided with an incentive to look upon fish and wildlife resources as agricultural crops to be produced and harvested just as are other crops. They do not have this incentive at present.



PLAN

Note: Elevation of top of constructed fill will vary along ℄ of fill to allow for one (1) per cent settlement.



SECTION ON CENTERLINE

Figure 1

TYPICAL FLOODWATER
RETARDING STRUCTURE

GENERAL LAYOUT

UPPER TRADEWATER RIVER WATERSHED
CHRISTIAN AND HOPKINS COUNTIES, KENTUCKY

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed Stewart	Date 2-61	Approved by	
Drawn Wallace	2-61	Title	
Traced		Title	
Checked		Sheet No. of	Drawing No.

U.S DEPARTMENT OF AGRICULTURE

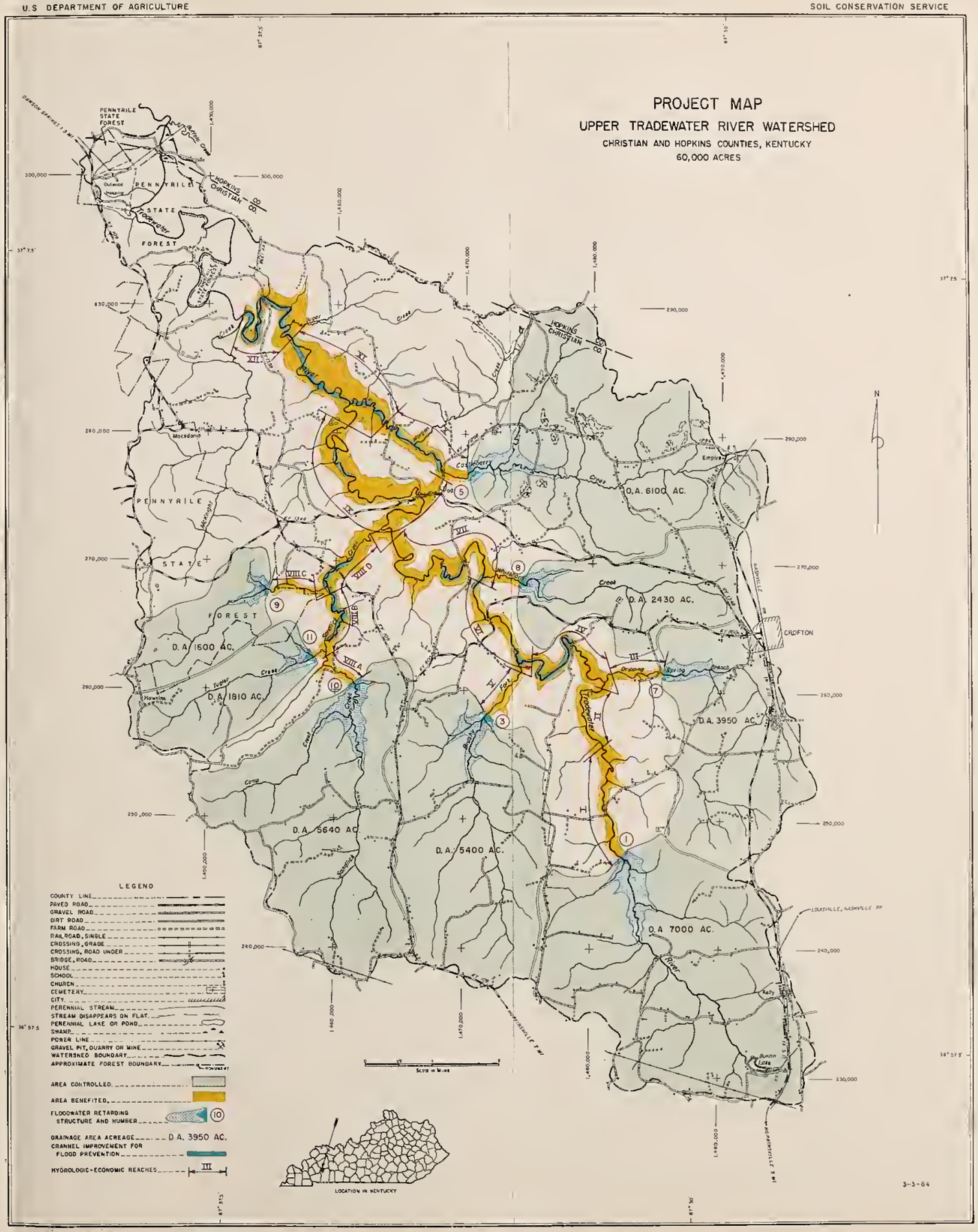
SOIL CONSERVATION SERVICE

PROJECT MAP

UPPER TRADEWATER RIVER WATERSHED

CHRISTIAN AND HOPKINS COUNTIES, KENTUCKY

60,000 ACRES



LEGEND

- COUNTY LINE
- PAVED ROAD
- GRAVEL ROAD
- DIRT ROAD
- FARM ROAD
- RAILROAD, SINGLE
- CROSSING, GRADE
- CROSSING, ROAD UNDER
- BRIDGE, ROAD
- HOUSE
- SCHOOL
- CHURCH
- CEMETERY
- CITY
- PERENNIAL STREAM
- STREAM DISAPPEARS ON FLAT
- PERENNIAL LAKE OR POND
- SWAMP
- POWER LINE
- GRAVEL PIT, QUARRY OR MINE
- WATERSHED BOUNDARY
- APPROXIMATE FOREST BOUNDARY
- AREA CONTROLLED
- AREA BENEFITED
- FLOODWATER RETARDING STRUCTURE AND NUMBER (10)
- DRAINAGE AREA ACREAGE — D.A. 3950 AC.
- CRANNEL IMPROVEMENT FOR FLOOD PREVENTION
- HYDROLOGIC-ECONOMIC REACHES — III

3-3-64

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